

DIURNAL TIME-ACTIVITY BUDGETS AND HABITAT USE OF RING-NECKED DUCK DUCKLINGS IN NORTHCENTRAL MINNESOTA

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ABSTRACT.—We studied diurnal time-activity budgets and habitat use of 36 individually marked, class II and III Ring-necked Duck (*Aythya collaris*) ducklings during 1983 and 1984 in northcentral Minnesota. Overall, ducklings spent 40.9% of their time foraging, 30.8% resting, 21.0% in comfort activities, 6.0% in locomotion, and 1.3% alert. Within broods, duckling activities were synchronized. When the duckling being sampled was foraging, resting, or engaged in comfort movements, 87%, 77%, and 56%, respectively, of the other brood members were engaged in the same behavior. Although male ducklings were larger than their female siblings, we detected no sex differences in activity budgets, dive rates, or the proportion of time spent in subsurface vs surface feeding. Only time spent in comfort and locomotor activities varied by time of day. Time spent in all activities, except comfort, differed between years. Five of six hens abandoned their broods before the ducklings could fly. Thereafter, ducklings spent more time foraging and less time resting and in comfort activities. Ducklings were never observed on shore. They spent 82.6% of their time in open water, although use of this habitat component was less than its availability (96.7%). While in open water, ducklings spent most of their time foraging (50.9%), resting (20.6%), and in comfort activities (19.2%). Exposed flats, consisting of islands of decayed organic debris, were used (16.0%) far in excess of their availability (0.3%), indicating ducklings actively selected this habitat component where they mostly rested (65.8%) and engaged in comfort activities (28.4%). Received 9 May 1991, accepted 1 Feb. 1992.

Time-activity budget studies are useful for quantifying how ducks apportion their time to cope with varying energy demands, how they cope with various environmental changes on a daily, seasonal, and year-to-year basis, and how these birds use habitat. Brood rearing is an important phase in the annual cycle of ducks. Several time-activity budget studies have quantified the behavior of brood hens and/or ducklings (e.g., Hammel 1973, Siegfried et al. 1976, Joyner 1977, Ringelman and Flake 1980, Afton 1983, Hickey and Titman 1983, Paulus 1984, Rushforth Guinn and Batt 1985). However, none of these studies has sampled individually marked ducklings of known sex nor have any time-activity budget studies been conducted on Ring-necked Duck (*Aythya collaris*) broods.

The Ring-necked Duck is a small-bodied diving duck that breeds primarily in the closed boreal forest of Canada. In the United States, the

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largest numbers are found in the Great Lakes states (Bellrose 1976), and it has been estimated to be the second most abundant breeding duck in the forested areas of Minnesota (Moyle 1964). Male Ring-necked Ducks weigh more than females except during the ovulation and laying periods (Hohman et al. 1988, Hier 1989). Because standard metabolic rates are a function of body mass, a larger bird must expend more energy (and thus require more food) to conduct any given activity than a smaller bird. If the sexual size dimorphism is also present in ducklings it should contribute to corresponding differences in time-activity budgets, especially with regard to foraging. These might be expressed as differences in total time spent foraging, the proportion of time spent in subsurface versus surface foraging, or in diving rates.

Male and female Ring-necked Ducks experience different selection pressures as reflected in higher survival rates of males (Conroy and Eberhardt 1983). This results in adult sex ratios skewed in favor of males (Mendall 1958, Bellrose et al. 1961, Jahn and Hunt 1964, Anderson et al. 1969). The sexes also have differing reproductive strategies with regard to time and energy expenditure (Hohman 1984). Intersexual differences in survival and reproductive strategies might be evident as early as the duckling stage and could be reflected in time-activity budgets.

Diving duck hens frequently abandon their broods before the ducklings can fly (Hochbaum 1944). Whether Ring-necked Duck ducklings alter their time-activity budgets after hens depart is unknown. How Ring-necked Duck broods modify time-activity budgets during the day or between years is also unknown. Habitat use by Ring-necked Duck broods has not been quantified.

We documented diurnal time-activity budgets and habitat use of Ring-necked Duck ducklings during age classes IIb–III (i.e., ducklings 25–60 days of age) (Larson and Taber 1980) and determined whether time-activity budgets differed by sex, time of day, or year and whether the hen was present with the brood. We quantified the degree of behavioral synchrony among brood members. We also documented dive rates and the ratio of subsurface to surface feeding by ducklings to determine whether these differed between sexes.

STUDY AREA AND METHODS

Broods were observed at Refuge Pond, a 45-ha wetland 7 km northeast of Bemidji, Minnesota. This wetland was also used by broods of Mallards (*Anas platyrhynchos*), Blue-winged Teal (*A. discors*), Wood Ducks (*Aix sponsa*), and Common Goldeneyes (*Bucephala clangula*). The wetland is a permanently flooded aquatic bed in a lacustrine system (Cowardin et al. 1979). A 25-ha floating mat of sedge (*Carex* spp.) and cattail (*Typha latifolia*) covered the northwest portion of the basin. The remainder of the wetland (20 ha) was largely open water.

We overlaid a grid on aerial photos of the wetland to quantify the proportion of each habitat component. Because we did not observe Ring-necked Duck broods using the floating mat portion of the wetland, we included only the open portion of the basin in our analysis. Most of this area was classified as open water. Water depth was ≤ 1.5 m. Aquatic plants were abundant in this zone and were dominated by large leaf pondweed (*Potamogeton amplifolius*), floating leaf pondweed (*P. natans*), white waterlily (*Nymphaea tuberosa*), and water shield (*Brasenia schreberi*). Hardstem bulrush (*Scirpus acutus*) was scattered throughout the open water zone but was too sparse to warrant a separate classification. Remaining habitat components included stands of cattail, stands of hardstem bulrush, small islands of floating sedge/cattail mat, and exposed flats consisting of islands of decayed organic debris.

Ring-necked Duck ducklings were captured by nightlighting (Lindmeier and Jessen 1961), sexed (Addy and MacNamara 1948), aged (Larson and Taber 1980), weighed, and banded with a U.S. Fish and Wildlife Service aluminum leg band. We also fitted each with a nasal saddle (Sugden and Poston 1968) coded to allow individual identification. Observations began two days after capture, allowing broods to reassemble and ducklings to habituate to nasal saddles.

Ducklings were observed with binoculars and an 80 \times telescope from a vehicle on a hill overlooking the wetland. Data were collected during 1-h sampling periods between 4 Aug.–14 Sept. 1983 and 8 Aug.–13 Sept. 1984. We conducted 1–4 sample periods ($\bar{x} = 1.9$) per day. Duckling activities and habitat use were recorded by instantaneous sampling (Altmann 1974) at 15-sec intervals at the tone of a metronome (Wiens et al. 1970). Activities were classified as: foraging, resting, comfort movements, locomotion, alert, and agonistic behaviors (Johnsgard 1965). Foraging included dives, dive-pauses, and surface feeding (dabbling and food-handling). Dive-pauses typically lasted only a few sec. Pauses lasting more than 15 sec were classified as alert or resting. Comfort movements included preening, bathing, stretching, wing flapping, or scratching (McKinney 1965). Locomotion included swimming not primarily associated with foraging, walking, and flying. During each sampling period, one duckling was observed for 30 min and a second duckling, usually within the same brood, was observed for the remaining 30 min. When possible, both sexes were observed during a sampling period. We alternated which sex was observed first and varied the individuals sampled. The day was divided into four time (CDT) blocks (1 = dawn–10:00, 2 = 10:01–14:00, 3 = 14:01–18:00, 4 = 18:00–dusk). Within each time block, the start of sampling was varied from day to day so that all daylight hours were sampled over the course of the study. We also recorded whether the sample took place prior to (hen present) or after (hen absent) a hen permanently abandoned her brood. Although duck hens sometimes leave their broods for short periods (e.g., Afton 1983, Paulus 1984), none of our samples were recorded during temporary absences.

During sampling periods, we documented behavioral synchrony among brood members by recording the activity of the focal bird at 2.5-min intervals and then scanning the other brood members and recording their activity. These data were only collected from ducklings that were still accompanied by the brood hen, because after hens departed, broods became less clumped spatially, making instantaneous scans difficult.

The sampling unit for activity budget analyses was one 30-min period. For each sampling unit, the number of instances of each activity was summed and converted to percent of time. To insure homogeneity of variance, the arcsin square root transformation (Anderson and McLean 1974) was applied to data before analysis. We estimated components affecting the variance of each activity using maximum likelihood methods with the BMDP3V program for general mixed ANOVAs (Jennrich and Sampson 1976). Our model consisted of a fixed component for the overall mean, another fixed component for the sex by time of day, by year, by hen presence category that described each datum, and three random components

representing three levels of sampling (i.e., broods, individuals within a brood, and repeated observations on an individual duckling). We tested the hypotheses that the variance attributable to broods and individuals was zero. These variance components did not appear to contribute significantly (no $P < 0.25$) to total variance. Therefore, we collapsed our original model to one that included only a single random component (replicates within a sex by time of day, by year, and by hen presence cell) and analyzed observed activities with more traditional MANOVA and ANOVA least squares models using the GLM procedure of the Statistical Analysis System (Helwig and Council 1979). Least square estimates of the various means were determined from the appropriate models and are reported as retransformed values.

To compare the relative amounts of time spent in surface foraging versus subsurface foraging (dive plus dive-pause), we subjectively omitted sampling units having fewer than 15 data points in the forage category to eliminate samples covering only a small portion of a foraging bout (foraging bouts typically lasted 15–25 min). For the remaining sampling units, we analyzed the proportion of foraging time spent in subsurface foraging using a least squares analysis of means model (Searle 1987). We tested 10 simple contrasts that accounted for as much of the four main effects (sex, year, time of day, hen presence) and all two-way interactions that missing cell means (6 of 32 cells) would permit. Prior to analysis the arcsin square root transformation was applied to these data.

When feasible, we also recorded the total number of dives by the focal bird during the 30 min it was sampled. Dive rates (the number of dives per 15-sec interval during subsurface foraging bouts) were calculated by dividing the total number of dives by the combined data points in the dive and dive-pause categories. We chose to omit from analysis sampling units having fewer than 10 data points in the combined dive and dive-pause categories. We used a paired *t*-test (Snedecor and Cochran 1980) to compare dive rates between sexes for those sampling periods when dive rate data were obtained from both sexes.

RESULTS

Activity and habitat use data were obtained from 36 ducklings (18 male, 18 female) from six broods. We obtained 135 30-min samples from males and 104 samples from females. Individual ducklings were sampled from 1–33 times (median = 5).

Activity budgets.—Overall, Ring-necked Duck ducklings averaged 40.9% of their time foraging, 30.8% resting, 21.0% in comfort activities, 6.0% in locomotion, and 1.3% alert (Table 1). Agonistic activities occurred rarely (<0.1% of the time) and were not analyzed statistically.

Broods often synchronized their activities (Table 2). Synchrony was most pronounced during foraging and resting as most of the other brood members foraged or rested at the same time as the focal bird. Comfort activities were less synchronized indicating that comfort activities also occurred when other brood members were foraging or resting.

Within broods, mean female weights at capture ranged from 77–96% of mean male weights. No female weighed more than any of her male siblings. However, tests for differences among activity budgets indicated no significant effects for sex or any interacting set of effects that included sex. Consequently, we omitted sex as an explanatory variable and reran

MANOVAs on the remaining three variables. The Wilk's Lambda test criterion indicated significant overall effects for time of day ($F = 2.31$, $df = 15$, 605 , $P = 0.0033$), year ($F = 6.73$, $df = 5$, 219 , $P = 0.0001$), hen presence ($F = 3.99$, $df = 5$, 219 , $P = 0.0018$), and the interaction between time of day and year ($F = 2.06$, $df = 15$, 605 , $P = 0.0103$). No overall effects were indicated for the year by hen presence ($F = 1.84$, $df = 5$, 219 , $P = 0.1059$), time of day by hen presence ($F = 0.82$, $df = 15$, 605 , $P = 0.6518$), or the year by time of day by hen presence ($F = 1.59$, $df = 15$, 605 , $P = 0.0705$) interactions. We used three-way ANOVAs to identify which activities were influenced by these overall effects.

Only time spent in comfort activities ($F = 4.49$, $df = 3$, 223 , $P = 0.0044$) and locomotion ($F = 7.04$, $df = 3$, 223 , $P = 0.0002$) differed by time of day. Comfort activities occurred most often during period 3 and least often during period 4 (Table 1). Locomotion was highest during period 3 and lowest during period 2.

Time spent in all activities except comfort differed between years (Table 1). Ducklings spent more time foraging in 1983 than 1984 ($F = 13.06$, $df = 1$, 223 , $P = 0.0004$). Conversely, they spent more time resting in 1984 ($F = 12.78$, $df = 1$, 223 , $P = 0.0004$). More locomotion ($F = 14.67$, $df = 1$, 223 , $P = 0.0002$) and alert ($F = 8.88$, $df = 1$, 223 , $P = 0.0032$) were observed in 1983.

We found a significant interaction between time of day and year for resting ($F = 3.10$, $df = 3$, 223 , $P = 0.0278$), locomotion ($F = 5.03$, $df = 3$, 223 , $P = 0.0021$), and alert ($F = 3.18$, $df = 3$, 223 , $P = 0.0250$). Whereas resting occurred least often in time periods 2 and 4 in 1983, resting occurred most often during these periods in 1984 (Table 1). In 1983, locomotion showed an increasing trend from time periods 1 to 3. However, in 1984 there was a sharp decline in locomotion between time periods 1 and 2. Alert showed an increasing trend throughout the day in 1983 but in 1984 showed decreases in time period 2 and especially period 4.

All six brood hens abandoned their ducklings during the study period. One left two days after her ducklings achieved flight capability. The other hens departed 3, 4, 8, 10, and 19 days before their ducklings could fly. These departures did not appear related to the disturbance caused by nightlighting operations as hens departed an average of 12.2 days after their ducklings were captured. Typically, ducklings remained together as a brood for the first few days after being abandoned. Gradually, they became more independent and spread out more widely on the pond. Ducklings began making short flights when two months old and dispersed from the pond 2–5 days later.

After hens abandoned their broods, ducklings spent more time foraging

TABLE 1
 MEAN PERCENTAGE OF TIME DUCKLINGS SPENT IN EACH ACTIVITY BY TIME OF DAY AND YEAR^a

Time period ^b	N ^c		Forage		Comfort		Rest		Locomotion		Alert						
	1983	1984	1983	1984	1983	1984	1983	1984	1983	1984	1983	1984					
1	32	20	43.5	41.3	42.4	22.0	22.6	22.3	25.3	30.9	28.1	7.7	4.2	6.0	1.5	0.8	1.2
2	45	29	51.2	26.2	38.7	18.9	18.8	18.8	20.3	52.8	36.6	7.9	1.9	4.9	1.5	0.4	1.0
3	39	24	38.4	35.9	37.2	26.1	25.4	25.8	24.2	31.1	27.7	9.1	6.1	7.6	2.1	1.2	1.7
4	31	19	58.7	31.7	45.2	16.6	17.1	16.9	12.9	48.3	30.6	8.6	2.6	5.6	3.0	0.3	1.7
Mean			48.0	33.8	40.9	20.9	21.0	21.0	20.7	40.8	30.8	8.4	3.7	6.0	2.0	0.7	1.3

^a Original analyses were conducted using arcsin transformed proportions. Depicted values are retransformed least squares means from the appropriate model.

^b 1 = dawn-10:00, 2 = 10:01-14:00, 3 = 14:01-18:00, 4 = 18:01-dusk.

^c Number of 30-min samples.

TABLE 2
COMPARISON OF ACTIVITIES BETWEEN SAMPLE BIRDS AND OTHER BROOD MEMBERS

Activity of sample bird	N ^a		Activity (%) of other brood members			
	Sample bird	Brood members	Foraging	Comfort	Rest	Locomotion
Foraging	100	643	87.3	6.8	5.1	0.8
Resting	100	638	3.3	17.1	77.7	1.9
Comfort	58	366	22.9	56.0	18.6	2.5

^a Number of data points obtained at 2.5-min intervals during samples.

($F = 14.31$, $df = 1$, 223, $P = 0.0002$) and less time in comfort ($F = 10.26$, $df = 1$, 223, $P = 0.0016$) and resting ($F = 7.49$, $df = 1$, 223, $P = 0.0067$) than they did while the hen was present (Table 3). Time spent in locomotion and alert remained unchanged.

We had 104 30-min samples for contrast analyses of subsurface versus surface foraging. No sex or time of day differences were found. The only explanatory variables making significant contributions toward overall variance in the proportion of foraging time spent in subsurface foraging were year ($F = 25.49$, $df = 1$, 78, $P = 0.0001$) and year by hen presence interactions ($F = 8.46$, $df = 1$, 78, $P = 0.0047$). Therefore, we ran an ANOVA model to produce estimates of means for the year by hen presence interaction. These indicated that the effect of the brood hen's presence was greater in 1984 than in 1983. After brood hens departed in 1983, ducklings spent a somewhat greater proportion of their foraging time in subsurface foraging (77.1%—present vs 95.8%—absent). However, in 1984 the proportion of subsurface foraging decreased markedly after brood hens departed (93.6%—present vs 49.1%—absent).

TABLE 3
MEAN PERCENTAGE OF TIME DUCKLINGS SPENT IN EACH ACTIVITY WHEN THE BROOD HEN WAS PRESENT OR ABSENT^a

Activity	Hen present	Hen absent
Foraging	32.2	49.6
Comfort	23.6	18.3
Rest	37.2	24.4
Locomotion	6.0	6.0
Alert	1.0	1.7
N ^b	98	141

^a Original analyses were conducted using arcsine-transformed proportions. Depicted values are retransformed least squares means from the appropriate model.

^b Number of 30-min samples.

TABLE 4
RING-NECKED DUCK DUCKLING HABITAT USE VS AVAILABILITY AND DUCKLING
TIME-ACTIVITY BUDGETS WITHIN EACH HABITAT COMPONENT ON REFUGE POND

Habitat component	Avail- ability (%)	Use (%)	N ^a	Activity within habitats (%)				
				For- aging	Comfort	Rest	Loco- motion	Alert
Open water	96.7	82.6	23,562	50.9	19.2	20.6	7.7	1.6
Exposed flat	0.3	16.0	4570	3.5	28.4	65.8	1.1	1.3
Bulrush stand	0.9	1.1	313	92.0	5.8	0.6	0.6	1.0
Floating mat island	0.7	0.3	82	0.0	50.0	48.8	0.2	0.0
Cattail stand	1.4	0.0	0	0.0	0.0	0.0	0.0	0.0

^a Number of instances focal ducklings were recorded in each habitat component.

We recorded 5043 foraging dives during 98 30-min sampling units. The overall mean dive rate was 0.874 ± 0.181 (SD) dives per 15-sec interval. For 15 sampling periods in which data were obtained from both sexes, dive rates did not differ by sex ($t = 2.01$, $df = 14$, $P = 0.0637$).

Habitat use.—Mineral soil made up 77% of the shoreline of the pond while floating sedge/cattail mat comprised the remainder. However, ducklings were never observed on shore nor were they ever observed in cattail stands along the pond edge. Bulrush stands and small floating sedge/cattail mat islands appeared to be used in proportion to their availability (Table 4). Ducklings spent the great majority of their time in open water, although use of this habitat component was somewhat less than its availability. Exposed flats were used far in excess of their availability, indicating that broods actively sought out this habitat component.

Ducklings used open water primarily for foraging, but substantial amounts of comfort and resting occurred there as well (Table 4). The small amount of time spent in bulrush stands was almost exclusively used for foraging. On the other hand, exposed flats and floating sedge/cattail mat islands were used primarily for resting and comfort activities.

DISCUSSION

Because of the sexual size dimorphism and differing intersex survival and reproductive strategies exhibited by adult Ring-necked Ducks, it can be argued that sex differences should be evident from the time of hatching. This appears to be the case with regard to size dimorphism but not in other aspects. Compared to other stages in their life cycle, ducklings of both sexes experience relatively similar energy demands associated with growth and development. At this stage, intersex energy budget comparisons are not complicated by differential costs of courtship, gamete pro-

duction, molt, etc. Major activities among brood members were synchronized, and both sexes foraged together in the same habitats, further indicating that intersex survival strategies are not markedly different during this period. Nevertheless, based on the size difference alone, we expected to find sex differences in time-activity budgets particularly associated with foraging. However, we detected no significant differences in activity budgets based on sex, nor did we find sex differences in the proportion of foraging time spent in subsurface versus surface feeding or in diving rates. Several factors may have accounted for this. The range of duckling age (and thus different mass) over which we sampled may have obscured subtle sex differences in foraging time or technique. Additionally, our most direct comparison (dive rates) had a small sample size and thus low power. Further, males may have selected a slightly different diet than females or there could have been sex differences in nocturnal activity. We were unable to measure either of these factors.

Most time-activity budget studies of ducklings have noted behavioral changes during the day, especially with regard to foraging. Early morning and late afternoon peaks in foraging have been reported for Blue-winged Teal, Mallard, and Ruddy Duck (*Oxyura jamaicensis*) ducklings (Joyner 1977, Ringelman and Flake 1980). Mottled Duck (*Anas fulvigula*) ducklings foraged most in the morning and less during midday before increasing foraging at night (Paulus 1984). Mendall (1958), though lacking quantitative data, reported that Ring-necked Duck broods tended to be more active in morning and evening but that feeding and resting periods occurred frequently throughout the day with little evidence of fixed routines. In contrast, we did not detect differences in time spent foraging throughout the daylight hours. Furthermore, time of day differences in resting, locomotion, and alert were inconsistent between years. The extent Ring-necked Duck duckling time-activity budgets change at night is unknown. During nightlighting operations, Minnesota Dept. of Natural Resources duck banding crews frequently observe broods of Ring-necked Ducks foraging (R. T. Eberhardt, pers. comm.).

Differences between years for all activities except comfort were likely related to changes in food abundance or availability on the pond. During age classes II and III, Ring-necked Duck ducklings eat a variety of plants and animals (Mendall 1958, Hohman 1985, McAuley and Longcore 1988). Although juvenile Ring-necked Ducks exhibit preferences for certain foods, availability plays a prominent role in food selection (Hohman 1985). Hohman (1984, 1985) noted year-to-year changes in foods available to Ring-necked Ducks and found that contributions of individual food species in class II Ring-necked Duck duckling diets differed between years

in northwestern Minnesota. If one assumes that nutritional needs of class II and III ducklings remain the same from year to year and that ducklings attempt to forage efficiently, then the amount of time spent foraging at any particular stage of their development should be a function of food abundance or availability. As sufficient food becomes easier to obtain, less foraging time is required. Relationships between food levels and the amount of time spent foraging have been noted in other waterfowl (Paulus 1988) as well as in non-waterfowl species (e.g., Maxson and Oring 1980). The only notable environmental difference between years was that August pond levels were 16.5 cm lower in 1984. This was the lowest August water level recorded on the pond during the 1979–1984 period (R. T. Eberhardt, unpubl. data) and it may have influenced abundance or availability of duckling foods. Further evidence of changes in foods was the fact that duckling foraging tactics differed between years. In 1984, particularly during the period after brood hens departed, ducklings spent considerably more time surface feeding (primarily dabbling) than during other phases of our study.

Given that time is limited, any change in time spent in one activity must be reflected in a corresponding change in time spent in other activities. We believe that the driving factors determining duckling time-activity budgets were requirements for foraging and feather maintenance, and that, in general, other activities (especially resting) filled in any time gaps remaining after these needs had been met. Time spent in comfort activities did not differ between years, likely because a certain proportion of time is required for feather maintenance regardless of other factors. When foraging time decreased in 1984, this time gap was compensated for primarily by increased time spent resting. An inverse relationship between time spent foraging and resting has also been noted in other waterfowl (Paulus 1988). The greater amount of time spent in locomotion in 1983 was associated with the higher foraging and alert time that year. Locomotion was recorded primarily as broods travelled between foraging sites, between foraging and loafing sites, or as they moved away from potential predators.

After hens abandoned their broods, ducklings spent more time foraging while spending less time resting and in comfort activities. Several explanations are possible. As ducklings approach adult size they require increased amounts of food based on the increase in their body mass alone. Without the hen to help guide them to good feeding locations, ducklings may initially be less efficient in finding sufficient food, although this may entail only a minor behavioral adjustment as ducklings had already been foraging on the pond 40–60 days. Also, there may have been some late

season changes in food abundance or availability resulting in increased foraging time. These explanations are not mutually exclusive and all three may have been in operation.

Although ducklings spent a smaller proportion of their time in open water than its percent availability on the pond, it is difficult to conclude that a habitat component used >80% of the time was not selected for. Indeed, ducklings did almost all of their foraging, as well as the majority of their resting and comfort activities, in open water. The only habitat component actively selected, relative to its availability, was exposed flats which ducklings used for resting and comfort activities. The fact that ducklings were never observed on shore suggests that they may have felt more secure in open areas away from dense vegetation. In this regard, exposed flats were located well away from shorelines or other heavily vegetated areas and offered broods easy access while affording an unrestricted view. By contrast, floating cattail/sedge mat islands, which had a similar availability but were seldom used, were well vegetated, were more difficult for ducklings to access, and afforded a much more restricted view of the surroundings.

The habitat use values that we recorded would be expected to vary somewhat among wetlands, depending on the availability and distribution of habitat components. Nevertheless, our data suggest that class II–III Ring-necked Duck broods have a preference for open portions of wetlands.

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